This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

UNIFICATION OF WEIGHTS AND MEASURES.

THE

METRIC SYSTEM:

ITS CLAIMS

AS AN

INTERNATIONAL STANDARD OF METROLOGY.

BY

JAMES B. THOMSON, LL.D.,

CHAIRMAN OF THE COMMITTEE ON WEIGHTS AND MEASURES OF THE NATIONAL EDUCATIONAL ASSOCIATION.

NEW YORK:

CLARK & MAYNARD, PUBLISHERS,

No. 5 BARCLAY STREET.

1874.

Hosted by Google

PUBLISHERS' NOTICE.

THE publishers beg leave to refer those, who wish to become acquainted with the

METRIC WEIGHTS AND MEASURES,

to the lucid explanation of the principles and applications of the System contained in

Thomson's New Practical Arithmetic.

Hon. JOHN A. KASSON, Chairman of the Congressional Committee on Weights and Measures, says, respecting it:

"I have observed with care your section devoted to the *Metric System* of Weights and Measures, now in legal use in the United States. No Arithmetic can now be complete, or claim public approval, without giving instruction to the student upon this system. *It seems to me you have admirably combined its elements in a few pages.*"

President F. A. P. BARNARD, LL.D., Columbia College, after paying a flattering compliment to the author's New Arithmetic, adds:

"But the feature of your book which it pleases me most to see, is the *presentation of the Metric System* of Weights and Measures."

Professor H. A. NEWTON, LL.D., Yale College, remarks:

"I like the *presentation of the Metric System*, and I am glad to see such progress in rejecting the obsolete and obsolescent in other parts of Weights and Measures."

Entered according to Act of Congress, in the year 1874, by

JAMES B. THOMSON,

In the Office of the Librarian of Congress, at Washington.

Electrotyped by SMITH & MCDOUGAL, 82 Beekman St., N. Y.

Hosted by Google

PREFACE.

AT the annual meeting of the National Educational Association, held at Trenton, N. J., August, 1869, a committee of three was appointed to report on "The practicability of introducing the Metric System of Weights and Measures into the United States, and the best means to accomplish that object." The committee consisted of Professor James B. Thomson, LL.D., City of New York, Chairman; Professor Charles Davies, LL.D., Fishkill-on-the-Hudson, and Professor Edward Brooks, A.M., Millersville, Pa.

At the meeting of the University Convocation of the State of New York, the same year, a committee of three was also appointed, charged with the duty of reporting "What further steps, if any, may be necessary in respect to the introduction of the Metric System of Weights and Measures." This committee consisted of Professor Charles Davies, LL.D., Chairman; Hon. Robert Hale, LL.D., and Professor James B. Thomson, LL.D.

At the meeting of the National Association, held in Cleveland, Ohio, Aug., 1870, the Chairman presented the substance of the following report. The Association accepted the report and passed the series of resolutions appended to it, setting forth,

"The Importance of the Unification of Weights and Measures to the progress of science, to civilization and commerce throughout the world."

"That in the judgment of the Association, the Metric System is nearer perfect than any other reached," and therefore has the "strongest claims to universal adoption."

"That its early introduction into our schools and seminaries of learning be recommended as the best means to popularize the system, and secure its general use among the people."

Hosted by Google

A copy of the report was requested for publication, but for want of means to verify some statistical matters, it was deemed inexpedient to allow it to be published at that time.

At the meeting of the University Convocation at Albany, the same year, Professor Davies made his first written report against the Metric System. In a prefatory note to that report, he says, "Prof. Thomson has not acted with the committee, and is, of course, not responsible for its doings."

Lest his non-action should be ascribed to indifference to the subject, justice requires him to say that he had no knowledge that his associates intended to make a report, or desired his co-operation, until after their report was submitted to the Convocation. The reason he did not enter his protest against the views expressed in the report at the time of its presentation, was because personal illness prevented his attendance upon the meeting.

The University Convocation in 1871 was favored by Rev. F. A. P. Barnard, S.T.D., LL.D., President of Columbia College, with an erudite and exhaustive address upon the "Origin and Nature of the Metric System of Weights and Measures."

The same committee being continued, the Chairman in 1872 made his second report against the system. At that meeting the substance of the following paper was submitted as a counter-report, urging the necessity of metrological reform, and advocating the claims of the Metric System to universal adoption.

With this brief explanation, it is now, at the solicitation of numerous friends of progress, offered to the public. With the exception of a few slight emendations of the text, and the addition of a few explanatory items, it will be recognized as the paper presented on the occasions referred to.

If it shall deepen the interest already felt in metrological reform, and contribute in any degree to the realization of a common international system of Weights and Measures throughout the world, its aim will be accomplished.

NEW YORK, Feb. 23d, 1874.

Hosted by Google

THE METRIC SYSTEM.

Mr. Chairman; Ladies and Gentlemen of the Association:

The committee appointed at your last annual meeting to report upon "The Practicability of introducing the Metric System of Weights and Measures into the United States, and the best means to accomplish that object," respectfully submit the following:

In common with other important enterprises for the advancement of civilization, the Metric System has received in different lands its full share of opposition. Among the most remarkable attacks it has encountered in this country are the strictures recently presented by gentlemen distinguished for mathematical and legal learning, to the University Convocation of the State of New York. These strictures are the more extraordinary as one of the gentlemen, from whom they emanated, had previously declared his conviction, over his own signature,* "that the Metric System is nearer perfect than any which can be reached, and that its adoption would greatly simplify and abridge all the applications of numbers to the various operations of commerce and business." The explanation of these conflicting views, this radical change of opinion, is chiefly found, we apprehend, in a misconception of the aims of the friends of metrological reform, and of the practical working of the Metric System, if introduced into our country.

Our opponents assume that the friends of metrological reform demand the adoption of the Metric System and the exclusion of our present system, *simultaneously*. They assert that the question is, "Shall the Metric System of Weights and Measures be adopted by

* The Metric System explained, etc., by Charles Davies, LL.D.

Hosted by Google

compulsory legislation, and the use of every other system forbidden?" They accuse "the friends of the Metric System of attempting to give such direction to public sentiment as shall lead to that result.

Again, they declare that "wherever the Metric System has been introduced, the exclusion of every other system, by penal enactments, has been found necessary." Allusion is also made to "dragooning the people into its use;" "fierce conflicts" are predicted in this country, where "the people are free and less habituated to blind obedience to imperial edicts." We have heard, Mr. Chairman, of the "Poetry of Mathematics." Here we have a specimen of what may be called *Sensational Mathematics.* These mathematico-sensational flourishes, if they have any meaning, assume that the friends of the Metric System have some sinister design concealed under the garb of metrological reform; that their aim is to take the people by surprise; to cheat them out of the old system and force them into the immediate use of the new.

We beg leave to assure the Association and the public that the advocates of metrological reform in this country, repudiate all such designs. They neither ask nor desire such legislation. Their object is alike *pacific* and *beneficent;* and while they pursue it with untiring zeal, they intend to employ no other than peaceful measures.

Object of Metrological Reform.

The object of the advocates of metrological reform is this:

First. To establish a uniform, international system of weights and measures, of such a character that its base and derivative units shall be *commensurable* quantities.

Second. That its derivative units shall increase and decrease by the *decimal,* or a *uniform* scale.

Third. That its different denominations shall be designated by a convenient, common nomenclature. The manner by which they hope to secure this reform will be explained hereafter.

The origin of the present system of weights and measures is veiled in obscurity. We received it from the father land; England

Hosted by Google

borrowed it from Rome, Rome from the Greeks, the Greeks from their ancestors, and so on to a remote age. Whoever may have suggested its original units, the grain, the barley-corn, the hand, the foot, etc., and whatever may be said of the *fitness* of these standards of comparison, certain it is, the *details* of the system were not the offspring of philosophical research, but of ignorance or chance. Yet amid the rise and fall of States and Empires, and all the political revolutions that have swept the earth during the past 2000 years; amid the gigantic conquests in science, in agriculture, and in commerce: amid the vast improvements in simplifying and abbreviating mathematical computations, which followed the introduction of the decimal notation into Europe, strange as it may seem, the essential features of this anomalous system of weights and measures, which sprung up in the world's gray dawn, held undisputed sway over all enlightened lands down to the commencement of the nineteenth century, and are still in vogue among all the English-speaking peoples of the present day. True, our Anglo-Saxon fathers expanded it into different kinds of weights and different kinds of measures, and substituted the foot and arm of some modern hero or potentate for those of an ancient or fabulous predecessor; but its leading features are still essentially the same, with its absurdities not only *unmitigated*, but *increased*. However well the system may have answered the few and simple wants of remote periods of antiquity, we need not say that it is totally inadequate to the demands of the present enlightened age; an age in which space is annihilated by the applications of science, and knowledge is communicated from land to land by lightning lines stretching around the globe.

Objections to the Present System.

Among the numerous objections to the present system are:

First. The standards by which its base units are determined, are *arbitrary* and *perishable*. These characteristics destroy all confidence in the experiments and researches of other ages and countries, encourage fraud, defeat the ends of commercial justice, and thus weaken the bonds that hold society together.

Hosted by Google

Second. Several of its base-units are *incommensurable* with each other. Thus, the linear rod ($16\frac{1}{2}$ feet) is incommensurable with the hand, the foot and the yard; the square rod ($272\frac{1}{4}$ sq. ft.), with the square foot and the square yard; and the cubic foot, the bushel and the gallon, with each other.

Third. Its base-units are also *incommensurable* with the base-units of all other systems of metrology. Weights and measures are the necessary instruments of commerce. Hence, incommensurability of the base-units of weights and measures in different countries, is a serious obstacle to diplomatic and commercial intercourse.

Fourth. The scale of increase and decrease is *irregular* and *variable.* It ranges all the way from 2 to 1728; and, as if to complete the inconvenience and absurdity of the system, ten of these ratios are *mixed numbers.* Taking the hand and foot as base-units, the application of the decimal scale to the various denominations arising from them, is impracticable; for, 10 hands are more than a foot, 10 feet more than a yard and less than a rod, etc.

Fifth. Most of the terms by which its 70 different denominations are designated, are *primitive* words, which are neither suggestive of the thing signified, nor analogous to each other; and therefore afford no aid to the learner in remembering them.

Sixth. Its nomenclature is a monument of confusion and absurdities. It employs three nominally different pounds besides the money pound, three kinds of length measure, and four kinds of capacity measure. In the subdivisions, it employs 9 terms in two different senses, 4 in three different senses, and 5 in four different senses; while the term *ton*, is used to signify a *long* ton, a *short* ton, a *cubic* ton, a *shipping* ton, a *register* ton, and a *liquid* tun. These double, triple and quadruple significations of the same word, make uncertainty more uncertain, and, taken together, form a medley calculated to bewilder the brain of the child, and blast all the redeeming qualities of the system.

Seventh. Owing to these great irregularities and apparent contradictions, the system necessarily consumes a vast amount of time and labor in learning it, and, when learned, is difficult to retain.

Hosted by Google

No one who has ever mastered these tables of weights and measures, and their applications, can forget the time and toil the victory cost him; and some, no doubt, can call to mind the *tingling* sensations which sometimes accompanied these efforts. And yet there are few, it is believed, who appreciate the amount of time and labor thus expended. Lord Brougham, after extensive consultation with teachers, came to the conclusion that "*one-third* of the time spent in mastering arithmetic would be saved by the adoption of a decimal system of weights and measures." Prof. Barret, a distinguished instructor for the artillery service, thinks "*two years* might be saved;" and Prof. de Morgan asserts that "the time devoted to arithmetic might be reduced by *one-half*, if not more, by the introduction of a decimal system." The opinions of practical teachers in our own country, who have been consulted as to the time consumed on this part of arithmetic, range from one and a half to two and a half years.

Assuming the arithmetical mean of these opinions as the standard, it takes pupils *two years* to acquire a tolerable knowledge of the system. The population of these United States, in round numbers, is 40 millions, and the average age of man $33\frac{1}{3}$ years. In $33\frac{1}{3}$ years, then, a whole generation of forty millions of children is to be educated. If one pupil wastes two years in mastering the present system, forty millions of pupils must waste *eighty millions* of years in a single generation. And if we multiply these eighty millions of wasted years by the countless generations in our own and other English-speaking lands, whose intellects have been and still are trammeled by these shackles, the product swells beyond comprehension.

Moreover, after all this toil and expense in storing away these incongruities, how often the memory fails to reproduce them when wanted. How few people, how few men, even of liberal culture, can change Troy to avoirdupois weight, or liquid to dry measure, and *vice versa*, without the help of a book! How few can even read the cabalistic characters which represent the denominations of apothecaries' weight, and which so effectually conceal from the people not

Hosted by Google

only the art of healing, but also the ignorance and blunders by which druggists and druggists' clerks every month, send so many to untimely graves.

Eighth. But the waste of time and toil caused by the system are not confined to childhood. It follows our young men from the schools to the counting-room and custom-house, and subjects them to immense inconvenience and labor, in regulating their accounts and adjusting the duties required by law. It presents its formidable front to the countless multitudes who throng the busy marts of trade, and imposes upon them also an intolerable burden in computing the quantities of the manifold exchangeable commodities, embracing the products of the earth and of human industry, as coal, minerals, lumber, fruits, cereals, etc., and manufactures, from the coarsest to the finest fabrics. We hazard nothing in saying that the time and labor of the thousands of business men who are daily engaged in computing the values of these exchangeable commodities through the instrumentality of our present weights and measures, would be diminished a *hundred per cent.* by the substitution of a uniform international system of metrology founded upon the decimal scale.

The last objection to which we would advert, is the great hindrance which the system presents to the progress of science. We have seen that the base-units of the system are not only incommensurable with each other, but also with the base-units of all other systems of metrology in Christian lands. To appreciate the obstructions which the system interposes to the progress of science, let us briefly refer to the abnormal and inconvenient relations between the different denominations of the linear unit to those of capacity and weight by which they are determined. The books say that a cubic foot of water is equal to 1000 ounces avoirdupois. But this is merely its approximate weight, and in exact calculations must be taken with many grains of allowance.

According to the experiments of Mr. Hassler, a cubic foot of distilled water, at its maximum density, weighs only 998.0607 ounces, the bushel is equal to 1.24444 cubic feet, or 77.6274 pounds, and the gallon to 0.13368 cubic feet, or 8.38888 pounds of distilled water at its

Hosted by Google

maximum density. Now, suppose the chemist or scientist wishes to deduce, by exact calculation, the weight of a body from its capacity, or its capacity from its weight, an operation of daily occurrence, who can estimate the expenditure of time and labor of a single operation?

And when to these unnatural relations between its own different denominations, we add the fact that its base-units are incommensurable with those of all other systems which, until recently, have prevailed in civilized lands, who can fail to see that the vast amount of time and labor required to change the results of experiments from the denominations of one system into those of another, has been and still is a most *serious hindrance* to the progress of science? With this incubus hanging over the world, the knowledge of one nation, in the language of Professor Hoffman, "is practically a sealed book to the students of others."

In view of these objections, we are brought to the inevitable conclusion that there is an *urgent necessity* for metrological reform; that the interests of commerce, of science, and of civilization, imperiously demand a *uniform, international system* of weights and measures. The great problem is, to find a system in which the entire family of civilized nations will unite.

Characteristics of a Universal System.

All agree that the *base-unit* of a universal system should be a *common measure* of all its derivative units; that its derivative units should increase and decrease by the *decimal*, or *some uniform* scale; that its denominations should be expressed by convenient terms; and that its standard unit should be such as will remain unchanged from age to age; will be secure against accident and fraud and the ravages of time; one that may be verified when desirable, and restored if lost. In a word, that it shall be *invariable, indestructible* and *reproducible.* Fortunately for man, nature presents two such objects, each of which combines the three qualities of invariability, indestructibility and reproducibility, viz.: the linear dimensions of the

Hosted by Google

earth and the linear measure of its attractive force embodied in the pendulum vibrating seconds.

Huygens, a distinguished Dutch astronomer, suggested a meridian as a standard as early as 1685, and the commission adopted it as the base of the Metric System in 1791. Cassini of Paris, suggested the pendulum as a base about the commencement of the last century. England adopted this standard in 1824, and declared the length of a standard yard to be 36 inches, such that 39.13929 of them are equal to the length of a pendulum vibrating seconds in *vacuo*, at the level of the sea, in the latitude of London.* As the English and the Metric Systems are the only systems whose standards are based upon the laws of nature, and are already in extensive use, it is the opinion of distinguished scholars that the choice of a universal system must lie between them. Let us briefly compare their claims.

While the advocates of the English system insist on retaining the "short, sharp terms," now employed in its nomenclature, they generally admit that its derivative units must be brought into commensurability with its base-units, and the increase and decrease of its denominations into harmony with the decimal or a uniform scale, in order to answer the conditions of a universal system.

Felton's Proposed Method.

Among the various plans embodying these changes, the most popular that has come under our notice is the one developed by Mr. J. H. Felton, of England, and recently indorsed by the joint committee of the Chamber of Commerce and the Geographical Society of the City of New York. Its outlines are as follows:

The unit of linear measure is the present legal foot. This is subdivided into inches and seconds, and has only one multiple, which is called a rod. These denominations increase by the scale of ten; 10 seconds making 1 inch, 10 inches 1 foot, 10 feet 1 rod. In square or surface measure, the link, the chain and the acre are the same as

* Note 1.

Hosted by Google

ours. Its denominations are links, staffs, reeds, plats, chains and acres, which increase by the scale of 10. The present legal pound is the unit of weight, the subdivisions of which are called grains, scruples, drams and ounces, and its multiples are stones, hundreds and tons. The unit of dry and liquid measure is the gallon, which contains 10 pounds avoirdupois of distilled water. Its divisions are called grains, scruples, drams, gills and pints, and its multiples ankers and tuns.

The chief arguments in favor of this system are: *First.* That its nomenclature consists of short, English words which are familiar to the ear. *Second.* Its principal units correspond in name with those already in use. These are plausible considerations. If we can pass from the present heterogeneous patchwork system to one that is acceptable to the brotherhood of nations, so easily as here set forth, the change is an object devoutly to be wished. But let us analyze the plan here proposed.

It is first assumed that children have a clear and definite idea of the meaning of the terms of the present system, because they are familiar to the ear. But however familiar to adults (everybody knows), they are new and strange to children. Again, of the twenty-six terms or denominations which it employs in the four measures of distance, surface, capacity, and weight, only five of them are taken in their present signification, twenty-one have new definitions, and three are used both in measures of weight and capacity, and therefore have a double meaning. The gallon or unit of capacity, differs from the present dry or liquid gallon, and therefore has no claim arising from present use. The foot, the chain and the pound are the only three of its units now established by law. Aside then from the antipathy to new words which led our ancestors to misrepresent the exactness of numbers, by calling 16 a dozen, 112 pounds a hundred weight, etc., an antipathy largely inherited by their descendants, the reasons in favor of this system are reduced to two—*First.* Three of its units are established by law. *Second.* Five of its terms are taken in their present signification.

Hosted by Google

Defects of the Plan for Decimalizing the Present System.

The plan proposed to decimalize the present system of weights and measures, has numerous and grave defects. Some of the more prominent are the following:

1st. Several of its units are *incommensurable* with each other. Thus, the gallon (10 pounds avoirdupois of distilled water) equals 221.8192 cubic inches. Again, the linear unit is the natural connection between linear and surface measure. But the linear link (7.92 inches), the square of which is a unit of land measure, is neither a decimal, nor yet an aliquot part of a linear foot or yard; consequently the square foot is incommensurable with the surveyor's unit of length and unit of surface.

2d. Some of its terms are employed in a *double sense*, and these meanings being different from those in which they are now used, are calculated to produce confusion in their application.

3d. Twenty-one of its boasted familiar terms have new significations. These familiar terms are wrested from that particular meaning which long established usage has assigned them, and are invested with a new and unfamiliar one.

The question here arises, how are we to know whether these twenty-one terms express the new or the old signification? And how is the pupil to decide which is the true meaning of these ambiguous terms? It may well be doubted whether these old names with new significations and double meanings, names which have no analogy to the thing signified, are not more objectionable and produce more perplexity than new names which are suggestive of the new ideas designed to be expressed.

In like manner it may be shown, that all attempts to engraft upon our English nomenclature, commensurability of base and derivative units with the decimal notation, are attended with inherent, insurmountable difficulties, and are calculated to perpetuate the evils they profess to remedy.

Hosted by Google

The Metric System.

The other plan proposed to secure international uniformity of weights and measures, is the adoption of the *Metric System.** The Metric System receives its name from the *Méter*, its principal standard unit of length. The meter is a ten-millionth part of the distance from the equator to the pole, and is equal to 39.37 inches nearly. From the meter, or unit of length, are derived the unit of surface, called the *āre*, the unit of capacity called the *lĭter* and the unit of weight called the *grâm.**

The several ascending and descending denominations are decimal multiples and submultiples of these units, and therefore, increase and decrease regularly by the scale of 10.

The names of the higher denominations are formed by prefixing to the several units, the Greek numerals *dek'a*, *hec'to*, *kil'o* and *myr'ia*, which respectively denote 10, 100, 1000, and 10000; as, dekameter, hectometer, kilometer, myriameter. Those of the lower denominations are formed by prefixing to the same units, the Latin numerals *de'ci*, *cen'ti*, and *mil'li*, which denote $\frac{1}{10}$, $\frac{1}{100}$, $\frac{1}{1000}$; as decimeter, centimeter, millimeter.†

Objections to the Metric System.

We are first met by the objection of Sir John Herschell, that the quadrant of a meridian is not the best possible standard, that the earth's equatorial diameter, or polar axis, or "the length of a pendulum vibrating seconds under certain definite and normal circumstances," would be preferable. It is also added that "all meridians are not of the same length; and that the meter is not exactly the ten-millionth part of the distance from the equator to the pole," etc. Without stopping to inquire whether the objection of the learned astronomer may not justly be regarded as hypercritical; waiving also

* For the details and application of the Metric System, the reader is referred to Thomson's New Practical Arithmetic.

† Note 2.

Hosted by Google

the assertion that all meridians are not of the same length, and that the meter was inaccurately determined, points which, according to eminent authority,* have not yet been proved, it is sufficient for our present purpose to say, that if all that is claimed on these points be true, this would not detract essentially from the value of the Metric System. For, it should be observed, the meter is no longer an abstract idea, or a mathematical conception. It is a definite length—the length of a material object. It consists of a bar of platinum deposited in the archives of France, and is therefore a *concrete unit.* In this respect it is on equal footing with the present standard yard of the English system.† It is exactly copied in measures within the reach of every branch of industry, and from its wide diffusion among the nations, may readily become a universal standard.

Again, it is objected that the introduction of the Metric System would cause certain manufacturing establishments great inconvenience and expense in changing their patterns and machinery.

In support of this objection, quotations have been freely made from a late speech of the Hon. Mr. Stephenson before the British Parliament. That his audience and the public may duly appreciate the weight of his testimony in favor of the present system, the Hon. member informs us that he is a Manufacturing Chemist; that the units, pound and cubic foot are constantly used, and are thebases of all his plans and arrangements. In making Sulphuric Acid, he says, he constructs his cisterns so that *every inch*, or *one-tenth* of an inch in depth, corresponds to 1 or 10 cubic feet, etc. Here you will observe the importance of the decimal scale, spontaneously cropping out. While arguing against the adoption of a system based upon it, the Hon. M. P. inadvertently acknowledges the importance of the principle, by employing it in graduating his cisterns. He also admits that a French Chemist can turn *kilograms* into *tuns* more easily than he can *pounds*. And why? Because, he adds, "the Frenchman divides by 1000, and he has to divide by 2240." These, Mr. Chairman, are important admissions, coming as they do from the foremost antagonist of the Metric System in the British Parliament. They

* Barnard on the Metric System. † Note 1.

Hosted by Google

clearly show the importance of a Decimal System of Weights and Measures, and the great inconvenience of the ever varying scales of our own system, to those who are called upon to make calculations by them. But what is the motive power that prompts this earnest opposition to the Metric System? Its introduction would oblige him to re-gauge his cisterns, make a new set of capacity measures, new scales, etc., and thus put him to an expense of some thousands of pounds sterling. Mr. Chairman, we submit whether a man who has a large pecuniary interest at stake, is a competent witness upon this subject? How is the testimony of self-interested witnesses regarded in our civil and criminal courts?

But the Hon. gentleman enumerates other parties among the various departments of industry who would suffer from the introduction of the Metric System; as coopers, sawyers, manufacturers of hinges, bolts, screws, etc. "If the pound is abolished," he asks, "how can the candle-maker know how to make his 4's, 6's, and 8's to a pound; and how will the housewife know whether her 6 candles weigh a pound?" To cap the climax, the honorable member indulges his grief over the anticipated abolishment of the milestones on the highways. "Are these to be shifted," he asks, "and are parliamentary trains, at a penny a mile, no longer to be heard of?" This was too touching! Parliament straightway voted down the obnoxious reform! The disinterestedness of such objections reminds us of a whaling merchant who opposed free schools on the ground that, "if boys are educated, they will no longer go before the mast; and who," he asks, "will then man our whale ships? The introduction of free schools," exclaimed the deluded man, "will destroy the whale fishery and beggar our families!"

With regard to the manufacturers of hinges, butts, etc., to whom reference has been made, whether in Manchester, Eng., or Waterbury, Conn., we can only say that *improvement* is the order of the day; these varying patterns are *footprints* in its march; and if the present owners of these establishments adhere to the styles now in vogue for ten years, the tyrant fashion, will rule both them and their goods out of market. But suppose the introduction of the Metric

Hosted by Google

System should cause manufacturers a temporary inconvenience and expense, shall the temporary interest of the few, with their annual dividends of twenty or thirty per cent., be allowed to override the welfare of the many, for all time?

It is also objected that the Metric System is inconvenient because it requires so many words or denominations to express ordinary quantities. In the next breath we are told that numbers, as a general rule, are read in the lowest unit, which makes the number too large for convenience. These objections contradict each other, and therefore both cannot be tenable. Moreover, it requires but a slight glance at the system to see that neither is valid. What would be thought of the knowledge of an American who should read 78 dollars 62½ cents, as "7 eagles, 8 dollars, 6 dimes, 2 cents and 5 mills," or as 78,625 mills? Equally unnatural is it to read 78.625 meters, as "7 dekameters, 8 meters, 6 decimeters, 2 centimeters and 5 millimeters," or as "78,625 millimeters." Again, that troublesome "lot of ground of 25 feet front by 100 deep," which it is said must be described, as "7 meters, 6 decimeters and 2 centimeters front by 30 meters, 4 decimeters and 8 centimeters deep," is properly described as 7.62 meters front by 30.48 meters deep. And instead of expressing 150 miles, the reputed distance from New York to Albany, by 229,680 meters, it is naturally expressed in round numbers, by 240 kilometers, the ordinary unit for long distances. It is unnecessary to say that a quantity expressed by the Metric System, may be read in any single denomination which shall be chosen as the unit, the lower denominations always being decimals of the unit which is selected.

It is further asserted that the introduction of the Metric System "would change the records of our entire landed property." Does the objector mean by this that all our farmers would be obliged to have their deeds recorded again, in order to preserve a legal title to their property? Every school-boy knows that *ex post facto* laws are unconstitutional. What effect the use of the Metric System can have upon the past records of our landed property, we confess our inability to see. Every transfer of real estate requires a new record, but this

Hosted by Google

record does not disturb the former. The validity of titles, the great landmarks, the boundary lines, etc., of estates, are no more affected by translating the dimensions from the given number of rods, feet and inches, "more or less," as formerly described, into meters and decimals of a meter, than if expressed in chains and decimals of a chain, according to present usage.*

It is also urged that the introduction of the Metric System would obliterate, to a certain extent, all present knowledge; that as great confusion would follow as "if we were forbidden to speak any language but the French." The obliteration of all or any considerable portion of the present knowledge the world possesses, would indeed be a great calamity; and the attempt of uninstructed Americans to speak French would present a ludicrous jargon. But we confess we do not see how this obliteration of knowledge is to be brought about, by the introduction of the Metric Language. Suppose the people were to learn the Metric System before they abandon the present system, would they have any reason to apprehend these deplorable consequences? Such forebodings then are purely imaginary—they arise from the preposterous supposition that the people are to be required to use certain instruments of calculation of which they are totally ignorant. The objection assumes that the human intellect is so constituted that learning a *new science* necessarily crowds out an *old one*, and consigns it to oblivion. It implies that new ideas are necessarily hostile to old ones, and by reason of their "incompatibility," they cannot dwell together harmoniously.

Finally, it is insinuated that "the system comes from a foreign land," and "is the offspring of infidelity." Such insinuations do great injustice to the intelligence and candor of Americans. Why should a system of metrology, derived from these sources, be any more obnoxious to the American mind than a system of Algebra, Geometry, the Mecanique Celeste, etc., borrowed from the same source; or, than the Arabic Notation, which came from a foreign pagan land, a land long known as the bitterest foe to Christianity. Such objections are too frivolous to require refutation.

* Note 3.

Hosted by Google

Claims of the Metric System.

Let us now turn our attention to some of the more prominent claims of the Metric System.

First. Its *base unit* is a common measure or multiple of all its *derivative* units. This, we have seen, is an indispensable characteristic of a system designed for universal adoption.

Second. It is constructed upon the principles of the *decimal* notation; its denominations, like those of our National currency, and the orders of simple numbers, increase and decrease regularly by the scale of *ten.*

But it is said that, however convenient the decimal scale may be for scientific calculations, for some practical purposes it is not so well adapted as the binary, quaternary, etc., and the adoption of the half meter, the quarter meter, etc., would be an abandonment of the system. This assertion adroitly assumes that if we adopt a system, we are necessarily tied down to all its details, and if we vary them, if we add to or subtract from them, we discard the system.

Let us examine this hypothesis. In our monetary system we employ the *half* dollar, the *quarter* dollar, etc., as subsidiary coins; and yet who will presume to say that we have abandoned the Decimal Currency of our fathers? The whole civilized world uses the half, the third, the fourth of a unit, yet who ever dreamed that the great principles of the Arabic notation are abandoned by so doing? Why then should the use of the half-meter, quarter-meter, etc., as subsidiary measures, in business matters, be proscribed as an abandonment of the Metric System.

Third. The *Meter* is a convenient, medium standard of measurement. It is worthy of remark, that the length of the meter is practically identical with the arithmetical mean of the English and American standard yard, the archine of Russia, the old French ell, and the pendulum which vibrates seconds; the difference being less than $\frac{17}{100}$ of an inch. Whatever may be the opinion of our opponents, taking the practical judgment of these enlightened

Hosted by Google

nations in connection with one of the elements of nature as our guide, we are warranted in saying, that the meter is a convenient medium standard of measurement.

Fourth. It commends itself by the *brevity* and *significance* of its nomenclature. And yet some complain "that the terms are new and hard. That each word consists of two parts, a base and a prefix," etc. Let us analyze this objection. Is a science to be discarded because its technical terms are new and hard? If so, what will become of modern chemistry, mineralogy, botany, and the whole catalogue of natural sciences? With what consistency can the advocates of a system embracing such terms as "avoirdupois weight, apothecaries' weight, hundred-weight, penny-weight, hogsheads, scruples," etc., complain of the "long-worded language" of the Metric System?

It is agreed by all parties that the technical terms of every science should be simple, exact, comprehensive, and few as possible. Let us apply this test to the metric nomenclature. To designate the different denominations of distance, surface, capacity, and weight, the Metric System employs *twenty-eight* terms only. Of these terms, seventeen, like eagles and dimes in our decimal currency, are not used in business calculations. *Eleven words*, then, practically constitute its whole vocabulary. Of these eleven terms, the four base-units, the *me'ter*, *āre*, *li'ter* and *gram*, are primitive words. The remaining seven are formed by prefixing to the base, certain numeral adjectives, four of which are Greek and three Latin

We ask, then, can another nomenclature be found; nay, is it possible to conceive of another, by which the weight and measurement of all objects, from the minutest animalcule that floats in air, to the mightiest globe that revolves through space, can be expressed by fewer, more simple, exact, and comprehensive terms? Each denomination has a *distinct name*, and each name a *definite meaning;* "no two words express the same thing, and no two things are signified by the same word." With respect, then, to simplicity, exactness, comprehensiveness, and fewness of terms, the metric nomenclature, we venture to affirm, stands unrivaled.

Hosted by Google

Fifth. The metric nomenclature has the further recommendation of being emphatically *cosmopolitan.* A terminology borrowed from a living language, can hardly fail to excite the prejudice of inferior nationalities, much more that of rivals and superiors. But the Metric denominations being derived from the classic languages of Greece and Rome, which have had an important instrumentality in molding all modern tongues, and have so greatly enriched the science and literature of all modern nations, is beyond the reach of jealousy and criticism, and must readily secure universal favor.

Sixth. Another advantage of the Metric System is, that it is easily learned, easily retained, and easily practiced. Instead of requiring months and years to become familiar with a long catalogue of varying scales, and the practical applications of terms of double and triple meaning, which are often forgotten in less time than is spent in memorizing them, the pupil has to learn only 11 words, 7 of which are suggestive of their exact signification, and the system is effectually and permanently mastered. Nay, more; as soon as the value of the "four base-units" are fixed in the mind, the values of all the derivative units, being formed by multiplying or dividing the base by 10, are at once apprehended. Its denominations are reduced from higher to lower, and from lower to higher terms, by simply removing the decimal point to the right or left, as in reducing our national currency to higher or lower denominations; and all its operations, in adding, subtracting, etc., are identical with those in simple numbers and decimals.

Seventh. The system has the cordial support of the great commercial, scientific, and educational interests of the age.

The International Statistical Congress, an institution inaugurated within the last twenty years for the purpose of collecting the facts pertaining to the different exchangeable quantities of commerce, both natural and industrial, at once felt the necessity of having a common standard of comparison and common terms of weights and measures in which to express the results of their inquiries in order to make them available. This learned body of political economists and statesmen adopted the Metric System as the standard of

Hosted by Google

comparison, and employ its terms in recording all statistical information respecting the objects of their researches.*

The system was unanimously indorsed by the International Conference on Weights, Measures and Money, held at Paris in 1867. At this conference twenty-two different nations were represented, among which were Great Britain, Russia, and the United States, and among its accredited delegates were Professors Leone Levi of London, De Jacobi of St. Petersburg, F. A. P. Barnard of New York, and many of the most eminent mathematicians and scientists of the age.

Again, the British Association for the Advancement of Science, and the Imperial Academy of Sciences of St. Petersburg have repeatedly memorialized their respective governments in favor of its adoption.

In England its adoption has been asked by more than forty chambers of commerce and boards of trade, farmers' clubs and workingmen's associations, and been advocated by such eminently scientific and practical men as Sir Wm. Armstrong, Sir Joseph Whitworth, and Sir Wm. Fairbairn.

In our own country its adoption has also been recommended by the National Academy of the United States, by the American Association for the advancement of Science, by the National Educational Association, the American Institute of Instruction, the New York State Teachers' Association, etc., etc. On the other hand, it is believed that within the last twenty years not a single scientific association in this or foreign lands, of respectable standing, has voted against its adoption. Is then the University Convocation, the highest educational representative body in the Empire State, prepared to be the first to put itself upon record in opposition to the system?

Finally. The Metric is the *most available* system of weights and measures that has any claim to universal adoption. The commercial and scientific movements of the nations that have recently been

* Report of Hon. Samuel B. Ruggles, Commissioner of the United States to the International Statistical Congress.

Hosted by Google

brought into juxtaposition by the electric wires, clearly indicate the certainty that a universal, international system of metrology must and will prevail. Its final triumph is a mere question of time. But we have already seen that the choice lies between the Metric and the English systems. Which of these systems then presents the most favorable prospects of success? Mr. Adams in his elaborate Report on Weights and Measures, truly remarks, "If universal uniformity, so desirable to human contemplation, be an obtainable perfection, it is now attainable only by the adoption of the new French System of Metrology, in all its important parts."

Scarcely seventy-five years have elapsed since the former was inaugurated. Its early history was surrounded by many of the most unpropitious circumstances. For years it was opposed by the combined influence of long established habits of ignorance, bigotry, political jealousy and hate; yet its simplicity and exactness have conquered the deep rooted prejudices of one people after another, till to-day it numbers among its followers twenty-one different countries, and is the only legal system of more than two-thirds of all civilized lands. Can any sane man therefore expect that all these peoples will be ready to abandon a system so highly satisfactory to themselves, and adopt our English system, with which they are but slightly acquainted, and whose irregularities they instinctively dread? The action of the British Parliament and of our own Congress seem to have anticipated the answer. The former, in 1864, and the latter, in 1866, passed laws permitting the employment of the Metric System throughout their dominions, with the evident expectation of its ultimate use. Indeed, it has already become the principal method used by the British and American analytic chemists and physicists in recording the results of their labors.

In view of these movements, every nation imbued with a spirit of liberality and a just regard for the good of the race, must pause before it opposes, on the narrow grounds of a personal preference for a vernacular nomenclature, a system which, confessedly, has all the fundamental elements of usefulness, and has already advanced so far in its career to universal adoption.*

† Note 4.

Hosted by Google

But here we are asked: "Is the introduction of the Metric System into our country a possibility?" "Can full-grown Americans be persuaded to lay aside their old tables and learn new ones?" "Will the minor tradesmen be induced to sell their wares by *meters*, *liters* and *grams*?" These questions neither surprise nor alarm us. They are evidently the suggestions of self-interest, or of the love of ease which too often springs up in the minds of men on the shady side of fifty.

Scientific Reforms of the Past.

Among human achievements during the past thousand years are three memorable reforms, which were as radical and difficult as the one now proposed. We allude to the Introduction of the Arabic Notation, the Reformation of the Calendar, and the Substitution in our own country of the Decimal for English Currency.

When the Arabic Notation was first brought to the doors of Europe, and asked for admission, the veteran conservatives and petty tradesmen of that age asked the same questions and interposed the same objections.* Nevertheless, the simplicity and comprehensiveness of the system, without prestige, or royal patronage, or compulsory legislation, swept the cumbersome modes of calculation of previous ages into oblivion, and at length secured universal use.

So thought and talked the nations of Christendom when the Reformation of the Julian Calendar was first suggested, and finally inaugurated by Gregory XIII, in 1582.† This reform set forward the Vernal Equinox from the 11th to the 21st of March, and thereby changed all the social, ecclesiastical, political, and scientific dates of more than twelve hundred years. When the New Calendar was adopted by the English Parliament, in 1752, the excitement was so intense, it is said the people ran after the carriages of the ministry shouting, "Give us back our 11 days." Nevertheless, so great was the importance to science, to social and religious institutions, of having civil dates coincide from age to age with the return of the

* Note 5.

† Note 6.

Hosted by Google

several seasons of the year, that at length it won a favorable hearing for the new calendar. Individual and national prejudice being overcome, one country after another wheeled into the ranks of its supporters, until every Christian land save Russia, long since adopted it to the exclusion of the Julian method.

So, likewise, felt many of our revolutionary fathers, when, in 1786, the Congress of the United States adopted the Decimal System of Currency. Nevertheless, after a sharp and protracted conflict, the old sixpences and shillings and pistareens, worn smooth by the pinchings of avarice, have been swept into the crucible and transformed into Decimal Currency. The superiority of the Decimal over the old State currencies, at length conquered ancestral prejudice, and trod under-foot the selfishness of petty shopkeepers and money-changers. The logic of these events is without a flaw. They clearly show the power of man to reform usages which have been intrenched behind the strongholds of prejudice for ages. The last of these reforms was achieved on American soil, and affords living proof that free-born Americans will be ready to lay aside a cumbersome, obnoxious system of metrology for a new and better one, as soon as they see that interest and convenience require the change.

How this Change is to be Effected.

The change from our own to the Metric System is doubtless to be accomplished, if accomplished at all, by the irresistible force of public opinion. But how is public opinion to be enlightened and concentrated upon this point? We answer, by giving to the Metric System the same facilities for being understood and practiced that are accorded to our own. But our opponents say that "legislation *has* placed the Metric System, in all respects, on the same footing with our own," and admonish us that "this is all which its friends have a right to ask." It is true, Congress, in 1866, passed a law permitting the Metric System to be used throughout the United States, but provided no means for disseminating a knowledge of it among the people.

Hosted by Google

The Sultan of Turkey recently issued an edict permitting his subjects to embrace and practice the Christian religion throughout his dominions. By parity of reasoning, then, Christianity, "in all respects, is placed on the same footing with" Mohammedism throughout the Ottoman Empire.

Let us see how the case stands. From time immemorial, the Moslem has been taught to love and obey the Koran; he inhaled its spirit upon his mother breast; his veneration for its principles has grown with his growth and strengthened with his strength. Around it cluster the influence of prestige, the traditions of many a hard-fought battle in its defense, and the sacred memories of a long line of ancestors, who sacrificed their lives in the propagation of its dogmas. At length the devotees of Mohammed are informed that the Bible presents a more excellent religion than the Koran, and the Sublime Porte grants them permission to adopt it. But as yet the masses know nothing of this new religion, except that it is a rival code of morals, which imposes upon them new doctrines and duties, the nature and extent of which they do not understand.

This is precisely the condition in which the Metric System is now placed in the United States. We ask, then, does the legal permission to use a system of metrology, of whose principles and application the people are ignorant, place that system in all respects on the same footing with one which for centuries has held a prominent place in every curriculum of study, and which every man, woman and child in the land, from the chief magistrate down to the humblest citizen, is compelled to use in procuring the daily necessaries of life? Is it unreasonable, then, for the friends of metrological reform to ask that the disadvantages, not to say disabilities, under which the Metric System is now placed in this country, may be removed, and that all classes of the community may become sufficiently acquainted with the system to pronounce an intelligent judgment upon its merits.

But how are the people to be made acquainted with its principles and applications? We answer, not by simple legislation; not by the strong arm of power, "vi et armis;" nor yet by mere resolutions of distinguished scholars and learned societies. No human

Hosted by Google

legislation nor arbitrary power can transform ignorance into knowledge; neither can individual or associated resolutions enlighten the public mind; consequently, however important all these instrumentalities may be in directing attention to the subject, they cannot remove the difficulties by which it is surrounded.

The first and most important instrumentality in removing these obstacles is the *School-room*. Let the system be introduced and carefully taught side by side with our own in all places of learning, from the primary school to the university, and the most formidable of the obstructions will at once be removed. We, therefore, most earnestly commend this step to School Committees, to Boards of Education, to Superintendents of Public Instruction, and to all Corporate Bodies whose province it is to direct the studies of children and youth.

Another important method of disseminating a knowledge of the system is, to discuss its claims in Lyceums, Atheneums, and other associations for mutual improvement.

In the next place, let all quantities of domestic and foreign goods upon which excise or import duties are levied, and all the legal weights of matter allowed to be transmitted through the Post-office Department, with all medical prescriptions and recipes of druggists, be expressed, both in the denominations of our own and the Metric System. Again, let all documents issued by the Bureau of Statistics, and the different State Departments which refer to exchangeable quantities, be expressed both in Metric and English denominations.

Last, but not least, let the co-operation of the press be invoked by the friends of reform. In the dissemination of knowledge, and the formation of public opinion, the power of the press is proverbial; I had almost said omnipotent. This stupendous power, we need not say, is ever ready to lend its services to the advancement of knowledge and the cause of humanity.

Let all these moral forces be secured, and the difficulties which now surround the system will disappear, and the people be prepared to appreciate its merits. The favorable tide of public opinion, formed at the well-springs of education, will soon roll through the

Hosted by Google

land with irresistible force. Seeing its great simplicity, its comprehensiveness, and its superiority over the present cumbersome system, all classes of the business community will readily adopt it, and the change be peaceably consummated.

We have now glanced at the leading features of the two rival systems of weights and measures, and the means by which we expect to see the final triumph of the Metric over our own. Viewed from this stand-point, it is not too much to say, that the system we advocate possesses the essential elements of simplicity, comprehensiveness, and universality; that its general adoption would cause civilization and commerce, by a single leap, to spring forward half a *century*. If these views are correct, it follows that of all the great problems which now engross the attention of the world, few are more important and far-reaching than the unification of weights and measures. It is a problem, to the solution of which, every nation on the globe is bound to contribute according to its ability, and in which all classes of society, from the rudest to the most refined, have a common interest.

Our country was the first to inaugurate a system of decimal currency, which won general admiration. Though we cannot be first in extending this principle to weights and measures, Heaven forbid that we should oppose its application to them. Such a course would argue demoralization of intellect, and bring lasting reproach upon our national character.

But we leave the subject with the guardians of science and those who minister at the altars of education, with the fullest confidence that its intrinsic merits are destined to win for it universal favor. In the prophetic words of the venerated John Quincy Adams, "If man upon earth be an improvable being, if that universal peace which was the object of a Savior's mission, and which is the desire of the philosopher, the longing of the philanthropist, and the trembling hope of the Christian, is a blessing to which the futurity of mortal man has a claim of more than mortal promise, then this system of common instruments to accomplish all the changes of social and friendly commerce will furnish the links of sympathy

Hosted by Google

between the inhabitants of the most distant regions; the Meter will surround the globe in USE as well as in multiplied extension, and one language of weights and measures will be spoken from the equator to the poles."

In this cursory view of the subject, we have endeavored to show the importance of metrological reform, the defects of our own system, the advantages of the metric, and the means by which a universal system may be secured. The conclusions we have reached may be summed up in the following resolutions:

Whereas, The commercial, diplomatic, and scientific intercourse between different nations is widely extended and rapidly increasing; and whereas, international intercourse, heretofore seriously impeded by the irregularities and imperfections of our own and other systems of weights and measures, would be greatly facilitated by a common system, in which all quantities of exchangeable commodities, scientific experiments and statistical information might be expressed; therefore,

Resolved, That in the judgment of this convention, effectual measures should at once be taken by Governments, by the friends of commerce and of science, to establish a uniform system of metrology for the use of the civilized world.

Resolved, That in order to be acceptable to the great family of nations and fulfill the great objects of its mission, said system should be founded upon an invariable standard and the decimal notation, that its base-units and derivative-units should be commensurable with each other, and be expressed in simple, concise terms.

And whereas, The Metric System, by common admission, "combines these elements in a higher degree than any other system reached;" and whereas, this system has already been adopted by so many enlightened nations; therefore,

Resolved, That we earnestly recommend its substitution for our own system, as soon as the people can be prepared for the change.

Resolved, That the quickest and best way to familiarize the people with its principles and applications, is to teach them in all our public and private schools, and, in connection with the present system, to begin to practice them in ordinary traffic, in competitive examinations for the civil service, in the requirements for entering college, scientific schools, the naval and military academies, etc.

Hosted by Google

NOTES.

NOTE I.—THE PENDULUM (p. 12).

Science is indebted to Galileo for the discovery of the great law of the pendulum, viz: the *isochronism* of its vibrations. His attention was attracted to the subject by the swinging of a lamp suspended from the ceiling of a church, and he applied the principle to the measurement of short intervals of time, in astronomical observations, by counting the vibrations. Huygens first demonstrated the relation between the length of the pendulum and the time of its vibrations, and connected it with clock-work. But in order to become available in measuring time, determining the figure of the earth, the force of gravity, or as a standard measure, its length, that is, the distance between the point of suspension and the center of oscillation, must be ascertained with exact precision. This problem involved many practical difficulties. The method in general was to suspend an experimental pendulum from a delicate point, and placing it before a good clock vibrating seconds of mean time, count the vibrations by the method of coincidences: that is, by starting both in the same direction, and observing the lapse of time before one of them gains or loses exactly two vibrations. The time of vibration being thus determined, the distance from the point of suspension was measured by a scale, and the proper corrections for the position of the center of oscillation were applied.

Borda, near the close of the last century, undertook a series of experiments with a view of making the pendulum the basis of a system of metrology, but this was afterwards abandoned, and an arc of a meridian adopted. His pendulum consisted of a slender iron wire about 13 feet long, terminated by a ball of platinum about $1\frac{1}{2}$ inch in diameter, the other end being attached to a point on a knife-edge suspension. The vibrations were performed in 2 seconds, and continued for 12 hours, the number being reckoned from the coincidences with the pendulum of an astronomical clock.

Among English scholars who have made the study of the pendulum a specialty, are Capt. Henry Kater and Francis Bailey. The convertible pendulum constructed by Capt. Kater on the principle first demonstrated by Huygens, viz.: that the point of suspension and the center of oscillation are interchangeable, seemed to promise entire accuracy, and was urged by the inventor as a standard of linear measure. The Astronomer Royal, in 1816, was directed to take suitable measures for ascertaining the length of the pendulum vibrating seconds, and for comparing the French and English standards with each other. At his request, a committee of nine were appointed to co-operate with him. Before any legislation took place with reference to the results of their experiments, the subject, in 1818, was submitted to a new commission consisting of Sir Joseph Banks, Sir George

Hosted by Google

Clark, Mr. Davies Gilbert, Dr. W. Hyde Wollaston, Dr. Thomas Young, and Capt. Henry Kater.

This commission, in their final report, recommended the adoption of the parliamentary yard made by Bird in 1760, as the standard, which, according to their last correction, bears the proportion of 36 to 39.1393 inches to a pendulum vibrating seconds under the conditions therein stated, the experiments being made at the temperature of 62° Fahrenheit.

Parliament, in 1824, passed a bill declaring the yard of 1760, by Bird, to be the Unit of Length, and called it the "Imperial Standard Yard," which, compared with a pendulum vibrating seconds of meantime in a vacuum, in the latitude of London, at the level of the sea, is in proportion of 36 to 39.1393 inches. It was also enacted, "That, if at any time hereafter, the said Imperial standard yard shall be lost, or destroyed, defaced or otherwise injured, it shall be restored by making a new standard yard, bearing the same proportion to such pendulum aforesaid, as the said Imperial standard yard bears to such pendulum." The new Imperial Measures went into use Jan. 1, 1826; and were made compulsory from Jan. 1, 1836.

It is worthy of notice, that since the standard yard was destroyed by the burning of the Houses of Parliament in 1834, a new standard yard, the one now in use, has been formed, not by resorting to the pendulum as a standard, but by a comparison of all the most reliable scales which could be collected.

The commission consisting of Airy, Bailey, Herschel, Lubbock, and Sheepshanks, appointed in 1838, to restore the lost standards, reported in 1841, that since the act of 1824, several elements of reduction of the pendulum experiments had been found to be doubtful or erroneous, etc.; that with the aid of the Astronomical Society scale, and a few other highly accurate copies, the standard could be restored without sensible error. The new standards were legalized in July, 1855.

NOTE II.—ORIGIN OF THE METRIC SYSTEM (p. 15).

The origin of the Metric System is due to France. In 1790, Talleyrand circulated among the members of the Constituent Assembly a proposition to reform the heterogeneous system of weights and measures then in vogue, or rather to form a new one, founded upon a universal standard. This proposition was adopted by the Assembly, and on the 22d of August, 1790, sanctioned by Louis XVI. At the request of the Assembly, the King wrote to the King of Great Britain, inviting the formation of a joint commission of members of the "Royal Society" and the "Academy of Sciences," to determine the standard, the object being to secure the co-operation of England and of other leading nations of Europe.

The political difficulties which soon sprang up between these two nations prevented the acceptance of this beneficent proposition. Spain, Italy, the Netherlands, Denmark, and Switzerland were represented in the Academy of Sciences, and took part in the proceedings. By a decree of the Assembly, a committee of five, Borda, Lagrange, Laplace, Monge, and Condorcet, were appointed to report to that body a standard, with the principles appropriate to the accomplishment of the object.

Three objects were suggested as suitable natural standards of length, viz.:

Hosted by Google

a quarter of the terrestrial meridian, a quarter of the earth's equator, and the pendulum vibrating seconds.

After careful deliberation the committee selected a quarter of the meridian as the standard of length, and proposed that its *ten-millionth* part should be taken as the unit of linear measure ; that as a second standard of comparison with it, the *pendulum* vibrating seconds at the 45th degree of latitude, should be assumed ; and that the weight of distilled water at the point of freezing measured by a cubical vessel in decimal proportion to the linear standard should determine the standard of weights, and vessels of capacity. This report was adopted by the Assembly. The most difficult part of the great problem was to determine by trigonometrical measurement, the length of the meridian extending from Dunkirk to Barcelona, a distance of about 10 degrees, or nearly 700 miles. This work was committed to Mechain and Delambre. Subsequently the prolongation of this meridian was measured by Biot and Arago as far as the Island of Formentara. From these measurements, in connection with the former measurement of the arc of a meridian in Peru, the length of the quadrant of a meridian was deduced. Dividing this distance by 10,000,000, one of the equal parts was called a Meter and adopted as the Unit of length.

The other great point to be determined was the *unit of weight*, which should bear a known relation to the unit of length, already adopted. The determination of this unit was assigned to Lefevre Gineau and Fabbroni. They selected a standard made of platinum, called a *kilogram*, which should represent the weight of a cubic decimeter of distilled water in a vacuum, at its maximum density. The thousandth part of this platinum standard was called a *Gram*, and adopted as the unit of weight. Now, as there are 1000 cubic centimeters in a cubic decimeter, it follows that the gram is the weight of a cubic centimeter of distilled water in a vacuum, at its maximum density. But the Assembly did not wait for the completion of this measurement before it gave the system a legal existence, deducing the meter from the length of a degree of latitude as formerly determined. The system, therefore, was provisionally established, Aug. 1st, 1793 ; and the nomenclature by which its various denominations are now distinguished, was adopted April 7th, 1795.

The commissions charged with these important operations, commenced their labors, under the auspices of the government, March 31st, 1791, but, owing to the causes mentioned, it was not until the 22d of June, 1799, that the *meter* and *kilogram* were finally determined as units of length and weight. On that occasion Laplace, the President of the National Institute, presented the results of their labors to the two branches of the National Assembly, with a standard meter of platinum made by Lanoir, and a kilogram of the same metal made by Fortin. The new system was approved by the government, and ordered to be used as the legal standards after Nov. 2d, 1801.

NOTE III.—DIVISIONS OF THE CIRCLE (p. 19).

It is often asked, why is not the Metric system applied to circular measure? We answer: *First.* Because the circle is independent of all exchangeable quantities; therefore it presents no obstacles to commercial intercourse between different nations. *Second.* The divisions of the circle are now the

Hosted by Google

same in all civilized lands; and as uniformity is the chief object of metrological reform, it is deemed inexpedient to change them.

NOTE IV.—PROGRESS OF THE METRIC SYSTEM (p. 24).

The following countries have adopted the Metric System unconditionally: France, the French colonies, Holland, the Dutch colonies, Belgium, Spain, the Spanish colonies, Portugal, Italy, Germany, Greece, Roumania, British India, Mexico, New Grenada, Ecuador, Peru, Brazil, Uruguay, Argentine Confederation, and Chili, the total population of which is 336,419,598. Wurtemburg, Bavaria, Baden, Hesse, Switzerland, Denmark, Austria and Turkey, whose population is 84,039,209, have adopted metric values, and may be regarded as committed to its future use. Add to these Great Britain and the United States, with a population of over 70,000,000, whose laws permit its use, and we have a grand total of more than 490,000,000.

NOTE V.—ORIGIN OF THE ARABIC NOTATION (p. 25).

We have no positive knowledge to whom the invention of the Arabic Notation is due. Not even the date nor the place of its origin, is known. The Arabians evidently became acquainted with it in the East, with which they had extended intercourse from the 9th to the 12th century. They called it *Hindasi*, which is an indication that they obtained it in India. Whether it was invented by the Hindoo philosophers, or borrowed from their neighbors, are unsettled theories. The prevailing opinion favors the former. But, however this may be, it is agreed that the Arabians communicated the new system to their flourishing Institutions of learning in Spain, and are justly entitled to the honor of introducing it into Europe.

This is commonly supposed to have taken place about the commencement of the 10th century. Some, however, place it as late as the middle of the 13th century. Assuming the latter as the correct date, more than three hundred years elapsed before it was generally used in business calculations among the nations of Europe. It had to contend not only with ignorance and self-interest, with the stolid inertia of so-called conservatism, and the strong attachment to the Roman System, which had long been in common use, but also with the deep-rooted prejudices of Christian nations, who at first regarded the decimal notation as one of the diabolical artifices, which the Mohammedans had obtained from the Powers of Darkness.

So strong was this prejudice against everything connected with the "Prophet," that the famous Roger Bacon, who visited the Saracen Institutions of Spain to perfect himself in Mathematics and Philosophy, was sharply persecuted by his countrymen for his rashness, and thrown into prison, on the charge of "practicing the arts of magic."

The Astronomers were the first to appreciate its importance, and according to Voscius, began to use it about the year 1250. The great question was, how to disseminate it among the people in Christian lands. This was at length accomplished, not by compulsory legislation, nor by force of arms, but by philosophical strategy. The Astronomers of France or Germany composed Almanacs, using the decimal notation, and incorporated in them a brief explanation of the system. These almanacs were sent to the various monas-

Hosted by Google

teries and religious houses in Europe, and were purchased with great avidity. In order to consult them respecting the festivals, seed-time and harvest, the weather, etc., the people were obliged to learn the Arabic characters, and the mode of calculating by them. The plan was triumphant. The great simplicity of the new system won the admiration of all, and began to supplant the old method. It is worthy of remark that then, as now, there were those of liberal culture, whose conservatism led them to stand aloof from innovations. Even some of the English Universities, from which better things might have been hoped, adhered to the Roman numerals in keeping their college accounts, till the 16th century; and in the parish registers of the South, the Arabic characters were not adopted before the year 1600.

NOTE VI.—THE GREGORIAN CALENDAR (p. 25).

The civil calendar of the United States and of modern Europe, was borrowed from the Romans. Previous to the time of Julius Cæsar, the Roman calendar had been subject to great confusion. So imperfectly had it been regulated through the ignorance or vice of the Pontiffs, to whose charge it was committed, that the Spring months were carried back into Winter, the Summer into Spring, etc., the discrepancy between the calendar and the seasons amounting to three months. To put an end to this confusion between civil dates and the return of the seasons, Julius Cæsar abolished the former calendar, and established a new one known as the Julian Calendar. He fixed the length of the year at $365\frac{1}{4}$ days, and through the advice of Sosigenes, an eminent Astronomer, restored the vernal equinox to the 25th of March, the place it occupied at the time of Numa, the second King of Rome. He also transferred the commencement of the year which originally began with March, as indicated by September, October, etc., to the 1st day of January, in the year 46 B.C. To provide for the fractional part of a day, he ordered an additional day to be given to February by reckoning the sixth of the calends of March or the 24th day of February twice, naming it *bissextus*, the *second sixth*. Hence, the years in which this extra day was intercallated, were called Bissextile, and correspond to our Leap Year.

In distributing the days among the several months, he assigned 31 days to the odd months, the first, third, fifth, etc., and 30 days to each of the even months excepting February, which in common years had only 29 days. This arrangement was alike sensible and convenient to be remembered. But it was soon disturbed by Augustus, whose vanity led him to entail his name upon the calendar by calling the sixth month August. And in order to make this month equal to July, which was named after his predecessor, a day was taken from February and added to it. This brought three months, July, August and September together, each of which had 31 days. To avoid this coincidence, September and November were each reduced to 30 days; October and December were increased to 31 days. The error of the Julian Calender consisted in making the civil year $365\frac{1}{4}$ days, which exceeded a mean solar year 11 minutes 10.3 seconds. By this error, the Vernal Equinox, which from the reign of Numa had been the great landmark for regulating civil time, gradually receded towards the beginning of the year, until in 325, when the council of Nice was held, it corresponded with the 21st of March.

Hosted by Google

As the means of Astronomical Calculations improved, this error became better established. In 730 the celebrated Bede discovered that the precession of the Equinoxes since the meeting of the council of Nice, amounted to about three days; and Roger Bacon, who died in 1292, in his "Treatise De Reformatione Calendarii," showed that the error amounted to seven or eight days. This discrepancy continued to increase till, in 1582, Gregory XIII established the new Calendar known as the "Gregorian Calendar," or "New Style." The error then amounted to 10 days, and the Vernal Equinox corresponded with the 11th of March.

In order to restore the commencement of the year to the same place in the seasons which it occupied at the time of the council of Nice, he ordered the 5th day of October to be reckoned the 15th of that month. This change restored the Vernal Equinox to the 21st of March, and the movable feasts of the church to the times fixed by the council of Nice, the two prominent objective points in the reformation of the Calendar. But it had been discovered that the error of the Julian Calendar was only three days in four hundred years, and consequently there should be only ninety-seven leap years in four centuries. To remedy this error, only one centennial year in every *four* was regarded as a leap year. Hence, the Gregorian rule for intercallation is this:

Every year the number of which is divisible by 4 without a remainder, is a leap year, except the centennial years, which are leap years only when divisible by 400 without a remainder. According to this rule the discrepancy between the Julian Calendar and solar time, which in 1582 was 10 days, continued the same till 1700; but 1700 being a leap year in the former, and a common year in the latter, the error during the 18th century was 11 days. Again, 1800 being a common year, during the present century it is 12 days; and from 1900 to 2100 it will be 13 days.

But by more refined instruments of observation and elaborate calculations, eminent modern Astronomers have shown that the civil year with the corrections of the Gregorian rule, exceeds the true solar year by 22.38 seconds, which amount to one day in 3866 years, or in round numbers one day in 4000 years. To correct this error, it has been proposed to make the year 4000 and all its multiples, 8000, 1200, etc., common years. With this last correction, the Vernal Equinox or commencement of the year, would not vary more than one day in 100,000 years.

The Gregorian Calendar was generally adopted by the Catholic countries of Europe soon after its promulgation; but Denmark and most of the Protestant states of Germany opposed its introduction with great pertinacity till 1700, and in some instances till nearly 1800. England resisted its introduction till 1752, a period of nearly 200 years. Amidst great popular excitement, the old Calendar was then abolished by Act of Parliament, and the new one adopted by dropping 11 days, and calling the 3d of September the 14th.

Russia still adheres to the Julian Calendar. Dates reckoned by the Julian Calendar are called Old Style; those reckoned by the Gregorian, New Style. To change a date from O. S. to N. S. at the present time, 12 days must be added to the former. Thus, Jan. 1st, 1874, O. S., is Jan. 13th, N. S.

Hosted by Google

NEW GRADED SERIES

OF

ARITHMETICS.

By JAMES B. THOMSON, LL.D.

COMPLETE IN THREE BOOKS.

I.—***New Mental Arithmetic,*** 144 pp., 16mo. . Price $0.35
II.—***New Rudiments of Arithmetic,*** 224 pp., 16mo. .50
III.—***New Practical Arithmetic,*** 384 pp., 12mo..... 1.00

Since the issue of the author's former Series of Arithmetics, of which MILLIONS HAVE BEEN SOLD, great changes have taken place in the commercial world. These changes necessarily demand changes in Text-books. To meet this demand ***"The New Graded Series"*** was undertaken, at the earnest request of many practical Educators.

The Publishers respectfully invite the attention of Teachers and School Officers to the plan and characteristics of the New Series.

I. GENERAL PLAN.

1. ***The Series consists*** of three Books—the object being CONVENIENCE and ECONOMY.

2. ***Each Book*** is *complete* in itself; hence, each can be used independently, or in connection with any series.

3. ***The Definitions*** and *Rules* COMMON to the three books, are expressed in the *same language.*

4. ***The respective Books*** abound in *Examples for Practice;* but no two examples in the different books are *alike.*

5. The ***Obsolete*** and ***Obsolescent*** in the Tables of Weights and Measures, the old State Currencies, &c., are eliminated.

Hosted by Google

6. ***Simplicity, Brevity,*** and ***Comprehensiveness*** in the Definitions and Rules, have been carefully studied.

7. The ***Series is designed*** to unite thorough discipline with a practical business education, the ***maximum*** of attainments with the ***minimum*** of time and expense.

8. Finally, the ***Great Objective Point*** has been to embody the best of the improved methods of treating each topic embraced in the series.

II. DISTINCTIVE FEATURES.

1. In the ***New Mental,*** the elementary *ideas of Numbers* are developed by the aid of counters, or sensible objects, which the pupil can both see and handle.

2. The ***Steps*** from counting to the simple *combinations* of numbers in solving concrete examples, are *carefully graded.*

3. The Pupil is treated, not as a ***passive Recipient,*** but as an ***active Agent,*** capable of *thinking* and *doing.*

4. His ***Inventiveness*** is called into frequent exercise, by the use of counters, the slate, etc., in illustrating for himself, the principles involved.

5. The ***Method of Self-help*** is extensively employed to cultivate an interest in the study. Children delight in having something to do.

6. ***In connection*** with the Mental Exercises, he is taught to express numbers by figures, and perform the more simple Slate exercises in adding, subtracting, etc.

---

1. ***The New Rudiments*** or Second Book, combines *Mental* with *Written Arithmetic,* in alternate exercises.

2. The ***Elementary Principles*** of the science are developed by *Oral* Examples.

3. The pupil is ***taught to apply*** these principles to the solution of problems requiring the use of the slate.

Hosted by Google

4. He is then ***led to generalize*** them to put the steps of the solution into a *concise Rule.*

5. ***Accuracy*** and ***Rapidity*** in the combination of numbers are secured by appropriate *practice.*

6. "A ***thorough mastery*** of this little book will prepare the learner for most of the problems arising in common life."—(ILL. SCHOOLMASTER.)

---

1. ***The New Practical*** or Third and last Book, is literally what its title indicates—*A Practical Arithmetic.*

2. The ***Principles of the Science*** are presented in a *Series of distinct and consecutive Propositions.*

3. ***Analysis***—the "Grand Common-Sense Rule," with its various applications, is a prominent feature throughout the book.

4. ***No principle*** is used in the explanation of another, until it has itself been explained or demonstrated.

5. The ***Rules*** are deduced from the analysis of examples, and are so constructed as to suggest the principles upon which they are based.

6. The ***Whys*** and ***Wherefores*** are distinctly given and illustrated.

7. The ***Arrangement of Subjects*** is in accordance with the natural order of the science. Hence,

8. The ***Common Applications*** of ***Surface*** and ***Solid Measure*** to the farm, the garden, artificer's work, etc., are placed immediately after Reduction.

9. ***Percentage and its Application*** to Commission, Profit and Loss, Interest, Banking, Stock Investments, U. S. Bonds, Exchange, etc., have received particular attention.

10. The ***Work contains*** much valuable information relative to business forms, and matters of science, not found in other books of the kind.

11. It is a ***Complete Arithmetic***—sufficiently thorough and extensive for Grammar Schools, High Schools, and Academies.

Hosted by Google

RECOMMENDATIONS.

From F. A. P. BARNARD, LL.D., President of Columbia College, N. Y.

You have shown the relations of numbers to many matters of common-life interest not usually noticed in elementary treatises on Arithmetic; and have done this in such a manner as fully to justify the title you have given to your work, of "Practical." The instructions in regard to the estimation of rates per cent, and to find the quantities corresponding to a given rate when the base is given, are clear, and in manner of presentation quite original. In the treatment of involution and evolution, you happily convey the geometrical notions corresponding to the arithmetical operations. * * *

From Professor J. H. VAN AMRINGE, A.M., Columbia College, New York.

I am much pleased with your "New Practical Arithmetic." The subject is developed consecutively and logically. The analysis of examples and the generalization of the results in the deduction of rules, is calculated to fix the attention of a learner, and to form a habit of correct reasoning. * * *

You have given much information pertaining to business forms and matters of science, and have thus adapted your work to the wants of every-day life among all classes of persons.

From HOWARD CROSBY, D.D., Chancellor of the N. Y. University.

I have examined Dr. Thomson's "New Practical Arithmetic" with enjoyment of its lucid method and attractive style.

Dr. Thomson's name is sufficient guarantee that the work is well done, the public having known him many years as a thorough, pains-taking, and sound scholar. The puzzling subjects of the "greatest common divisor" and the "least common multiple," "involution" and "evolution" are made clear and attractive. I know of no other Arithmetic which I prefer.

The *Franklin figures* are used in the work, and add much to its beauty.

From Rev. THOMAS W. HUMES, D.D., Chancellor of East Tenn. University, Knoxville.

The Series is evidently the work of a mind discriminating and thoroughly informed upon the subject; and besides its general excellence, it has meritorious features which specially adapt it to use in our schools.

From Prof. E. W. EVANS, Cornell University, Ithaca, N. Y.

I am favorably impressed with it (The Practical); indeed, I should expect to be with any book of yours.

From GEO. W. CLARKE, Ph.D., President Mount Washington Collegiate Institute, New York City.

Having used for a year Thomson's "New Graded Arithmetics," it gives me pleasure to say that they have been a source of unusual profit to my pupils, and of great "aid and comfort" to my teachers.

From Prof. L. M. JOHNSON, A.M., Prin. State Normal School, N. J.

Upon careful examination of Thomson's "New Arithmetics," we decided to use them in our Normal and Model Schools, as the best suited to our wants. They have given great satisfaction to all parties.

Hosted by Google

From G. W. SAMSON, D.D., President Rutger's Female College, Fifth Avenue, New York City.

The Arithmetics of Dr. Thomson were selected for use in this College last Autumn, because they were regarded as superior to any before used.

They have given entire satisfaction to both teachers and patrons.

From PRINCIPALS of Male Grammar Schools, New York City.

The undersigned have examined Thomson's "New Arithmetics," and take pleasure in saying that we consider them a decided improvement on his former series, and admirably adapted to the wants of our pupils. * * *

(Signed by forty-five Principals.)

From PRINCIPALS of Female Grammar Schools, New York City.

The undersigned have examined Prof. Thomson's "New Arithmetics," and take much pleasure in saying that we regard them as works of great merit, and admirably adapted to the wants of our schools. * * *

They are, withal, eminently practical. The amount of information pertaining to business matters found in them is an important consideration in the education of girls as well as boys, and cannot fail to commend them to the attention of all practical educators. (Signed by forty-three Principals.)

From Prof. M. H. MARTIN, A.M., Supt. State Model School, N. J.

Thomson's "New Graded Arithmetics" are now used in the New Jersey State Model School.

In clearness and brevity of rules, accuracy of definition, simple and practical analysis, rejection of obsolete matter, close adaptation to actual business usages, we consider them decidedly superior.

From Prof. JOHN BROCKLESBY, Trinity College, Hartford, Conn.

"The Practical" covers all the ground required, and within a reasonable number of pages. I think it well adapted for the purpose intended.

From C. C. STIMETS, A.M., Prof. Math. State Normal School, N. J.

Thomson's "New Graded Series of Arithmetics," especially the "Practical," I take pleasure in heartily commending.

I am much pleased by the *conciseness* to which he has arrived in working out the *completeness* of the subject. Also, by the *practical applications* and the introduction of various new topics, bringing the work *up to the times.*

From Prof. H. B. SPRAGUE, Prin. of Adelphi Academy, Brooklyn.

I am greatly pleased with the "New Practical." It is difficult to see how it could be much improved.

From J. F. STREET, A.M., Prin. Farnum Preparatory State Normal Sch., Beverly, N. J.

We have adopted "Thomson's New Arithmetics" because we like them better than any others.

From Hon. J. B. JAMES, Supt. of Public Instruction, Newark, Ohio.

I have examined Thomson's work on Arithmetic ("New Practical"), and have no hesitancy in pronouncing it *good.*

Hosted by Google

From Hon. HENRY KIDDLE, A.M., Superintendent of Public Instruction, City of New York.

I have examined the new Series of Arithmetics by James B. Thomson, LL.D., and am much pleased with the improvements introduced therein. These books have been adopted by the Board of Public Instruction of the City of New York, and I have no doubt they will prove a valuable addition to the text-book list.

The above expresses very fully and clearly my own views of the practical value of Prof. Thomson's New Series of Arithmetics.

T. F. HARRISON, A.M., Asst. Supt. and Prof. of Methods of Teaching.

From J. K. PAYNE, A.M., Prof. Math. E. Tenn. University, Knoxville.

I find so many admirable points, that I will not attempt to enumerate. I consider them superior to any of their competitors. They will win on their merits. I shall recommend their adoption in our city schools. Your books will do much to facilitate the progress of pupils everywhere—especially in the common schools, where the teachers can afford but little help to the learner beyond that contained in the text. * * *

From the PRINCIPALS of Grammar Schools, City of Brooklyn.

The undersigned have examined Thomson's "New Graded Series," and are free to say that they are much pleased with the plan and its execution. The author has evidently "**struck the Key-note**," combining the principles of numbers with their practical application to business.

The definitions and rules are clear and concise, the examples fresh and abundant, the "whys and wherefores" clearly stated, the works embody the very best of the improved methods of treating the subjects, and are fully up to the times. (Signed by thirty-two Principals.)

From Prof. W. B. DWIGHT, A.M., State Normal School, Conn.

We regard this as one of the most valuable and faultless of the recent contributions to arithmetical school literature. * * * In all departments of the study, constant reference is made to the actual processes employed in business transactions; and many important topics not usually found in arithmetics, are introduced.

From J. H. FANNING, A.M., Asst. Supt., City of New York.

Prof. Thomson's "New Series of Arithmetics" contain many improvements over other works of the kind, which, in my judgment, add greatly to their value as text-books.

From W. HASBROUCK, A.M., Ph. D., Prin. Hasbrouck Institute, Jersey City, N. J.

I have used for more than a year Thomson's "New Practical Arithmetic" in all the departments of my school, having upwards of one hundred and fifty pupils in Arithmetic. All of my teachers are much pleased with the work. We like its arrangement of subjects, the conciseness and clearness of its rules, its variety of examples, and their practical and commercial character. The Analysis of Examples is most excellent, and I can most unreservedly recommend the book to all teachers and officers of schools.

Hosted by Google

From IRA MAYHEW, A.M., President of Mayhew's Business College, Detroit, Mich.

Thomson's Arithmetics, as formerly published, were excellent. I consider his "New Graded Series" an improvement on the old. The "New Practical" will hereafter be used as the text-book in this department of the Mayhew Business College.

From J. E. SEAMAN, A.M., Prof. Mathematics, Central High School, New Orleans.

The simplicity and clearness with which the principles of the Science are presented in "The New Practical," the progressive character of the work, and the great variety and adaptability of the examples to business calculations, commend it as a model book for Grammar Schools.

From WM. W. PAYNE, A.M., Professor of Math., Carlton College, Minn.

It (The New Practical) contains just enough matter in extent and variety, is sharp, clear, and terse in principle and illustration, and carries on the face of its pages marks of practical business life which pupils cannot imbibe too early.

From Prof. M. L. BROWN, A.M., Prin. Young Ladies Institute, Auburn, N. Y.

I desire to express my unqualified approval of it, "The New Practical," and my desire that it shall be introduced into the schools of this vicinity.

From T. C. MENDERHALL, A.M., Professor of Physics and Mechanics, Ohio Agricultural and Mechanical College.

I have examined with great pleasure "Thomson's New Graded Series." The primary book contains many useful and ingenious suggestions to the teacher, in regard to the gradual development of the idea of number, while the "Practical" is comprehensive and complete.

From WM. F. PHELPS, A.M., Prin. State Normal School, Minn.

I have looked over your books with care, and am pleased to note that you have kept pace with the march of improvement in methods of instruction, and have adapted your books to the most advanced requirements of modern teaching. * * * You have the whole matter in a nut-shell.

From J. E. MEYER, A.M., Prin. Auburn High School, N. Y.

I am especially pleased with the practical points of Thomson's "New Practical Arithmetic." * * *

From Prof. WASHINGTON CHOATE, Adelphi Academy, Brooklyn.

For the omission of much that is unimportant, and the introduction of new rules, and improved methods of instruction; for a complete analysis of the various operations, and a logical arrangement of topics, I commend Thomson's works as superior to all others now in use. * * *

I most heartily concur with Prof. Choate in regard to Dr. Thomson's Arithmetics. (Signed) J. W. CHANDLER, *Inst. in Arith.*

Hosted by Google

Blanks for Harris's Book-keeping.
Comprising Day-Book, Journal, and Ledger. Per set..... $1.00

Kingsley's Cicero de Oratore.
By J. L. Kingsley, Prof. of Latin in Yale College..... ... 1.00

Noyes' Penmanship..... 20

Olmsted's Compendium of Natural Philosophy.
For Schools and Academies. Revised by E. S. Snell, LL.D., Prof. of Nat. Phil. in Amherst College..... 1.65

Wiley's Elocution and Oratory.
A thorough Treatise on the Art of Reading and Speaking. By Charles A. Wiley, Teacher of Elocution. 12mo, cloth..... 2.00

Young's Government Class-Book.
By A. W. Young. 12mo, roan, cloth sides..... 1.50

Young's First Book on Civil Government.
By Andrew W. Young. 16mo, half roan..... .. 60

Wickham's School Register.
Different Sizes..... $0.90, $1.80, $2.75, 3.75

Wickham's School Diary.
Per Dozen..... 75

Hobbs's School Diary.
Per Dozen..... .... 1.00

School Editions of the Following Poems.

Cowper's Task.
18mo, half bound..... 38

Milton's Paradise Lost.
18mo, half bound..... 38

Pollock's Course of Time.
18mo, half bound..... 38

Scott's Lady of the Lake.
18mo, half bound..... 38

Thomson's Seasons.
18mo, half bound..... 38

Young's Night Thoughts.
18mo, half bound..... 38

Pope's Essay on Man.
With Clark's Grammatical Notes. 18mo, half bound..... 20

Hosted by Google